Bathymetric Digital Elevation Model of the Mariana Trench

Lim, E.[1], M.G. Sutherland[1], D.Z. Friday[1], B.W. Eakins[1], S.J. McLean[2]

[1] Cooperative Institute for Research in the Environmental Sciences, University of Colorado-Boulder, Boulder, Colorado
[2] National Oceanic and Atmospheric Administration, National Geophysical Data Center, Boulder, Colorado

Summary

In the summer of 2012, the NOAA National Geophysical Data Center (NGDC) developed a 6 arc-second bathymetric digital elevation model (DEM) of the Mariana Trench and adjacent seafloor in the Western Pacific Ocean to support visualization efforts of the area. The Mariana Trench DEM includes data from a variety of sources, including international, federal and academic partners. The DEM is referenced horizontally to the World Geodetic System of 1984 (WGS 84), in geographic coordinates, and a vertical datum of sea level.

DEM Specifications

The Mariana Trench DEM was developed to the specifications listed in Table 1.

Table 1. DEM Specifications for the Mariana Trench Bathymetric DEM.

Grid Area	Mariana Trench and adjacent seafloor
Coverage Extent	139º to 150º E; 10º to 22º N
Coordinate System	Geographic decimal degrees
Horizontal Datum	World Geodetic System of 1984 (WGS 84)
Vertical Datum	Sea level
Vertical Units	Meters
Cell Size	6 arc-second
Grid Format	ESRI Arc ASCII grid

Figure 1 provides a graphic display of seafloor topography in the Western Pacific and extent of the Mariana Trench DEM. Source data were obtained and processed for an area slightly larger area than that illustrated in Figure 1 in order to minimize edge-effects potentially introduced during the gridding process.
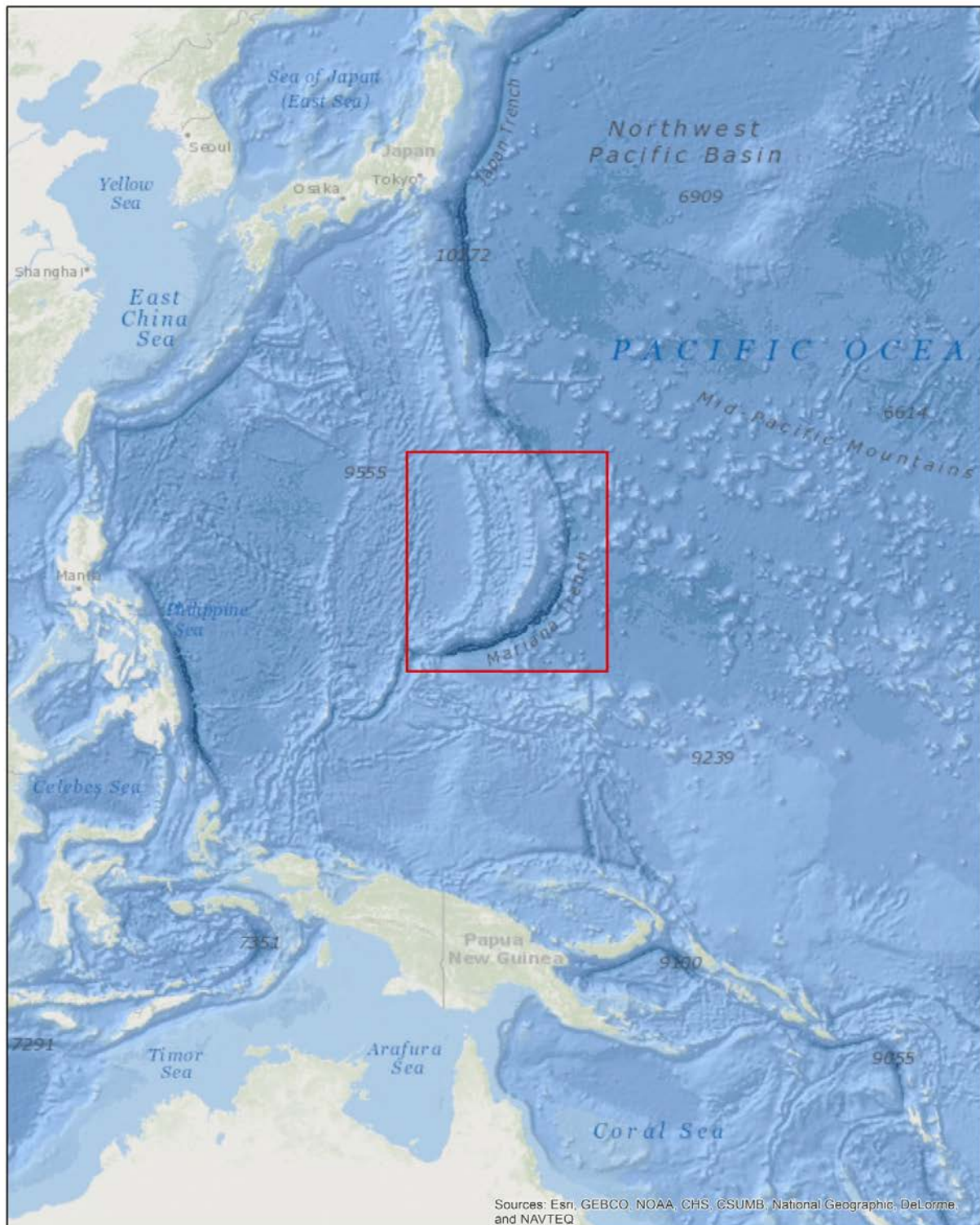
Figure 1. Seafloor topography in the Western Pacific Ocean. Mariana Trench DEM
extents are indicated by the red box.

Data Sources, Processing and Evaluation

Bathymetric data were obtained for the study area from a variety of sources, including NOAA NGDC, the University of New Hampshire Center for Coastal and Ocean Mapping (UNH-CCOM), the US Naval Oceanographic Office (NAVOCEANO, obtained via NOAA NGDC), the Japan Agency for Marine-Earth Science and Technology (JAMSTEC) and the Japanese Coast Guard Hydrographic and Oceanographic Department (CSS). Additionally, the ETOPO1 global relief model (publicly available via NOAA NGDC) was used in areas where high-resolution multibeam bathymetric data were not available.

Table 2. Bathymetric data sources used in the development of the Mariana Trench DEM.

Source	Date	Data Type	Spatial Resolution	Original Horizontal Datum	Original Vertical Datum
NOAA NGDC	1985-2011	Multibeam Bathymetry	Resolution varies among individual surveys	WGS 84	Instantaneous Sea Level
UNH-CCOM	2006-2010	Gridded Multibeam Bathymetry	100 m	WGS 84	Instantaneous Sea Level
NAVOCEANO	2010-2011	Multibeam Bathymetry	Resolution varies among individual surveys	WGS 84	Instantaneous Sea Level
JAMSTEC	2002-2011	Multibeam Bathymetry	Resolution varies among individual surveys	WGS 84	Instantaneous Sea Level
CSS	1993-2005	Multibeam Bathymetry	Resolution varies among individual surveys	WGS 84	Instantaneous Sea Level
ETOPO1	2009	Gridded Global Relief Model	1 arc-minute	WGS 84	Sea Level

Once the data were obtained, they were converted to ASCII xyz files and was gridded using MB-System[1]. The relative contribution from each source dataset to the final DEM is summarized

---

[1] MB-System is an open source software package for the processing and display of bathymetry and backscatter imagery data derived from multibeam, interferometry, and sidescan sonars. The source code for MB-System is freely available (for free) by anonymous ftp (including "point and click" access through these web pages). A complete description is provided in web pages accessed through the web site. MB-System was originally developed at the Lamont-Doherty Earth Observatory of Columbia University (L-DEO) and is now a collaborative effort between the Monterey Bay Aquarium Research Institute (MBARI) and L-DEO. The National Science Foundation has provided the primary support for MB-System development since 1993. The Packard Foundation has provided significant support through MBARI since 1998. Additional support has derived from SeaBeam Instruments (1994-1997), NOAA (2002-2004), and others. [Extracted from MB-System web site.] URL: http://www.ldeo.columbia.edu/res/pi/MB-System

in Table 3. Precedence was given to UNH-CCOM data while the low-resolution ETOPO1 grid was smoothed to a cell size of 6 arc-seconds and used only to fill in data voids. It must be noted that some 'positive' elevations (i.e. elevation greater than 0 meters) are present in the Mariana Trench DEM over 'dry land'. However, for all intents and purposes, these values should be ignored, as the focus of DEM development in this case lies solely in the bathymetric realm.

Table 3. Data hierarchy used to assign gridding weight in MB-System.

Source	Relative Weighting
UNH-CCOM Multibeam Bathymetry	100
NOAA Multibeam Bathymetry	10
NAVOCEANO Multibeam Bathymetry	10
JAMSTEC Multibeam Bathymetry	10
CSS Multibeam Bathymetry	10
ETOPO1 Global Relief Model	.01

Qualitative checks (visual inspection) were performed during DEM development to ensure consistency among adjacent datasets and to highlight and remove any anomalous bathymetric data. No quantitative evaluation was performed on the final grid.

More information

For more details on the procedures followed in developing the Mariana Trench DEM, please see: http://www.ngdc.noaa.gov/mgg/coastal/coastal.html